BUTTE COUNTY

GENERAL PLAN

SAFETY ELEMENT

ADOPTED MARCH 15, 1977

SAFETY ELEMENT

CONTENTS

TABLES

FIGURES

MAPS

SAFETY ELEMENT

A. GENERAL

1. State Requirements

Section 65302.1 of the Government Code requires county general plans to include a Safety Element "...for the protection of the community from fires and geologic hazards including features necessary for such protection as evacuation routes, peak load water supply requirements, minimum road widths, clearances around structures, and geologic hazard mapping in areas of known geologic hazards."

The Council on Intergovernmental Relations 1973 General Plan Guidelines advise that the Safety Element should include an identification and evaluation of safety hazards and a general policy statement which establishes measures to abate and protect from the effects of recognized hazards.

2. Planning Relationships

From the standpoint of hazards, some of the County's lands are more suited for certain activities than others. Policies and ordinances can be developed to make sensible use of our economic and land resources while recognizing known hazards.

The Safety Element relates to all other General Plan elements, but it is most directly related to the Land Use Element, the Circulation Element, the Housing Element, and the Conservation and Open Space Elements.

a. Land Use Element

Hazardous conditions, a prime determinant of land use capabilities, are considered in the Land Use Element. The Land Use Element designates appropriate uses for lands determined unfit for development and human occupancy because of natural hazards and the need to respect those hazards. The Land Use Element can also advocate that development within areas of high risk consider all aspects of the hazard, including safeguarding structures and natural resources.

The identification of natural hazards can contribute to the development of policies and standards, regulating the type, location, and intensity of land use in relation to the hazards. Land use controls can also prohibit some types of activities and developments that may obstruct access or endanger life and property.

b. Circulation Element

Natural hazards affect the location and design of circulation facilities. Construction standards and safety measures can be established for all circulation systems in hazardous areas. In case of a major emergency or disaster, evacuation routes and major transportation systems must be located, designed, and maintained for mobility and safety.

c. Housing Element

The presence of natural hazards will limit housing type, cost, and density. Depending on the degree of hazard, new housing developments will need to incorporate within their design any special hazard abatement or control methods and

incur the costs of doing so. Development of land considered "acceptable risk" should be encouraged while land unfit for structures for human occupancy should remain undeveloped.

d. Conservation and Open Space Elements

The identification and recognition of hazardous areas can lead to policies aiding in the development of open space and the conservation of natural resources. Land determined unfit for human occupancy can be preserved for agriculture, for the enjoyment of scenic beauty, for recreation, and for the development of natural resources.

B. GEOLOGIC HAZARDS

1. Objectives

The primary objective of the Geologic Hazards sub-element is to prescribe policies to reduce loss of life, injuries, and property damage, and to deal effectively with the socio-economic disorder which could result from geologic hazards in Butte County. Secondary objectives are to:

- Map and evaluate known geologic hazards.
- Provide general criteria for the development of other General Plan elements.
- Heighten public awareness of geologic hazards.

2. Landslides

a. Characteristics

Landslides are a downward and outward movement of slope-forming materials composed of rock, soil, artificial fill, or combinations

thereof. A similar but slower movement is called "creep." Landslides, in the strict sense, do not creep; however, creep is related to slope stability and the potential for landslides to develop. A landslide may move rapidly as in a soil or rock avalanche, or it may move very slowly for hours or even weeks. The volume of material may vary from millions of cubic yards to less than 1 cubic yard. The landslide movement normally results in the development of cracks, ridges, scarps, and faults, all of which may not exist or be easily identified in a specific landslide.

Landslides are classified by the U.S. Geological Survey into several groups (U.S. Geological Survey, MF 493). See Appendix C for a description of four of the more common landslide groups.

The formation of landslides is affected by:

- Type of material. (Unconsolidated soil, soft rock or surface deposits generally move downslope easier than consolidated soil or hard bedrock.)

- Structural and physical properties of earth materials. (The orientation of layering, structure, and zones of weakness of most rock and sediment relative to slope direction will greatly affect landslide potential.)

- Steepness of slopes. (Landslides usually occur on moderate to steep slopes.)

- Water. (Areas of moderate or steep slopes with a high ground-water table or seasonally high rainfall have frequent landslides because water commonly decreases the resistance to sliding. Water decreases the cohesive forces that bind clay minerals together, lubricates surfaces along which slippage may occur,

adds weight to surface deposits and bedrock, can cause volume changes in the material, and mixes with fine-grained unconsolidated materials to produce wet, unstable slurries.)

- Amount of vegetation. (Abundant vegetation with deep roots tends to hold bedrock and surface deposits together, thereby increasing ground stability.)

- Proximity to areas undergoing active erosion or man-made cuts and fills. (Rapid erosion along stream courses and reservoir shorelines makes slopes in these areas particularly susceptible to landsliding.)

- Earthquake generated ground motion. (Strong ground motion can trigger movement of marginally stable earth slopes and loosen hillside materials for future failure.)

Factors in the identification of potential landslide areas include degree of slope, type of bedrock, type of soil, amount of rainfall and previous landslide activity (most new landslides occur in areas of previous landsliding). One of the most important parameters is the degree of slope. An examination of slopes and known landslide areas in the County indicates that most landslides occur on slopes greater than 15 percent with very few on slopes of 5 to 15 percent or less.

Because of their physical and chemical character, certain bedrock units are more susceptible to landsliding than others. Also important are the types and thickness of soils that tend to develop over these bedrock units. As a consequence, two adjacent areas may appear to be similar in most respects but may differ greatly in landslide potential because of bedrock or soil conditions.

The prediction of landslides at a specific site requires analysis of the complex interrelationships of all of the above factors as well as a detailed onsite investigation. Because such detailed information is not available in Butte County, the identification of potential landslide areas is preliminary and delineates only relative slope stabilities.

b. Distribution

There are landslides in Butte County, but they do not appear to commonly occur. There is, however, a potential for landslides in some areas. These areas, shown in Map III-1, are described below.

The areas of lowest landslide potential in Butte County are the generally flat lands of the Sacramento Valley; however, there appears to be some landslide hazard due to the potential for liquefaction of soils bordering the Sacramento River and its tributaries (see Map II-2 in the Seismic Element of the General Plan). An area of generally low landslide potential lies in the hills south of Oroville and in the generally flat uplands north of Oroville such as the Paradise area. The slopes bordering the flat uplands, such as the slopes around Table Mountain, are highly susceptible to landsliding.

The areas of apparent highest landslide potential lie in a north-south belt through the mountainous central area of the County. In this area, fairly well developed soils overlie impervious bedrock on steep slopes which at times undergo very heavy rainfall. The slopes most susceptible to landslides are underlain by older metavolcanic rocks which have undergone extensive deformation and deep weathering.

Areas of granitic rocks and Tertiary sediments in the central region of the County also have a high potential for landslides.

Even though the granitic rocks are of an age and nature that normally result in stable slopes, some steeper areas have been extensively deformed and weakened. The Tertiary sediments subject to landsliding consist mostly of sandstone, claystone, siltstone with minor conglomerate shale, and lignite. This rock group, found predominantly north of Oroville and known as the Ione Formation, is generally overlain with older basalt flows and is exposed only where the basalt flows have been eroded, such as around Table Mountain.

3. Subsidence

a. Characteristics

Subsidence is a sinking of a large area of surface materials in which there is no free side and the material is displaced vertically with little or no horizontal component. Subsidence, usually as a result of man's activities, is fairly common in California.

Generally, there are two potential causes of subsidence in Butte County, ground-water withdrawal, and oil and gas withdrawal.

Ground-water withdrawal subsidence is the most extensive and the most damaging in California. This type of subsidence has been found in large areas of the San Joaquin Valley and in some areas of the Sacramento Valley. Generally, subsidence is a greater hazard in confined ground-water basins and particularly in those that contain compressible layers of silt and clay. Subsidence hazard is also greater in areas where initial lowering of the water table is occurring in valley fill alluviums with layers of silt and clay such as those in the Sacramento Valley. In the past, irrigation demands in the Sacramento Valley have been mostly supplied by surface waters. Now, ground-water pumpage is increasing and there are extensive long-term declines in ground-water levels in a few areas.

There are recent and on-going studies of subsidence in the Sacramento Valley. These studies, by the California Department of Water Resources, the U.S. Geological Survey, and the U.S. Bureau of Reclamation, show that measurable land subsidence has probably occurred in areas of intensive ground-water pumping comprising approximately 100 square miles north of Willows and possibly a third of the valley floor south of the Sutter Buttes (Lofgren and Ireland, Preliminary Investigation of Land Subsidence in the Sacramento Valley). As much as 2 feet of subsidence apparently has been caused by heavy ground-water pumping east of Zamora. At several locations between Davis and Zamora subsidence exceeds 0.5 foot. A U.S. Geological Survey report states that localized subsidence, possibly caused by natural gas withdrawal, has occurred near Corning and Arbuckle. In most of the valley, elevation data are inadequate to positively determine if subsidence has occurred.

The amount of subsidence caused by ground-water withdrawal depends primarily upon six factors: 1) the magnitude of water level decline; 2) the thickness of the water bearing strata tapped; 3) the thickness and compressibility of the silt-clay layers within the vertical sections of ground-water withdrawal; 4) the duration of maintained water level decline; 5) the number of water withdrawals in a given area; and 6) the geologic structure and general geology of the ground-water basin.

The damaging effects of ground-water withdrawal subsidence include gradient changes in roads, streams, canals, drains, sewers, and dikes; damage to water wells resulting from sediment compaction; and flooding of low-lying areas. These effects should be of serious concern. Many of the public facilities and systems constructed with slight gradients could be significantly damaged by even very small elevation changes.

There has been subsidence at 22 oil and gas fields in California. Even though most of these are in the Los Angeles basin, the potential for subsidence from oil and gas withdrawal exists in other areas of the State as well. Differential subsidence, a common form of subsidence from oil and gas withdrawal, generally extends beyond the producing area in the form of a shallow bowl. The subsidence takes place in much the same way as that of ground-water withdrawal and the effects are also much the same. Subsidence caused by gas withdrawal alone does not usually reach magnitudes comparable to subsidence caused by oil or ground-water withdrawal.

b. Distribution

Land subsidence is a potential hazard in Butte County. Areas of potential subsidence in the County are confined to the Sacramento Valley and include local areas of heavy ground-water withdrawal and the six producing gas fields shown in Map III-1. According to investigations by the U.S. Geologic Survey, the areas of heaviest ground-water withdrawal extend about 2 miles north and south from Chico and in a 1-mile radius around Gridley. The amount of subsidence that could take place in the County will depend primarily on the amount of ground-water withdrawal. The likelihood of subsidence resulting from large ground-water drawdowns during droughts should be a major concern to all agencies responsible for the County's water resources, public facilities and economic well-being.

4. Erosion

a. Characteristics

Erosion generally involves two distinct activites, wear and removal of earth or rock material and transport from one site to another. The erosion process includes weathering,

solution, abrasion, and movement. The level of erosion depends upon the soil texture and structure, slope, vegetative cover, and type and amount of water runoff.

Long-term damage can result from sheet and gully erosion, wind erosion, erosion of stream courses, and erosion of lakeshores. Depositional damages can occur on flood plains, rivers, lakes, and stream channels and drainage ditches. The construction of roads, reservoirs, and subdivisions, farming, and logging frequently accelerate the erosion process and exacerbate the damage.

b. Distribution

Map III-2 shows the degree of erosion that may be expected in Butte County where the protective vegetation is removed by construction, fire, or cultivation. Using information from the United States Department of Agriculture Soil Conservation Service Report and General Soil Map of Butte County, California, 1967, there are five classes of erosion hazard:

- None - Slopes less than 2 percent, with subsoil permeability ranging from moderately rapid to rapid.

- Slight - Slopes of 2-9 percent with permeability ranging from moderate to moderately rapid with weak soil profile development.

- Moderate - Slopes of 9-30 percent with soils of no profile development to weak profile development and slopes of 9-15 percent with moderate profile development.

- High - Slopes of 30-50 percent in soils with no profile development to weak profile development

and slopes of 15-30 percent on soils with moderate to strong profile development.

- Very High - Slopes in excess of 50 percent on soils with no profile development and slopes over 30 percent with moderate to strong soil profile development.

Typically, the areas of high erosion hazard are underlain by volcanic and metavolcanic rocks. The areas of very high erosion hazard are typically underlain by granitic rocks. The areas of high to very high erosion hazard typically have a moderate to high annual rainfall (approximately 30-60 inches).

Soils of the Sacramento Valley are typically of the slight erosion class with slight to high erosion classes along major streams and drainages. The areas northwest and south of Oroville are typically in the moderate erosion class but contain isolated areas of high erosion potential. The eastern two-thirds of the County is typically in the high to very high erosion class. The areas surrounding Lake Oroville and extending south to Bangor and Hurleton and north to Richardson Springs and Stirling City are typically in the high to very high classes. The tops of the basalt flow plateaus and the volcanic areas near Butte Meadows and Jonesville are generally in the slight to moderate erosion class.

5. Expansive Soils

a. Characteristics

Expansive soils are soils which have a potential for shrinking and swelling with changes in moisture content. Extensive damage to structures and roads can result from the shrinking and swelling process.

The volume change of the soil is influenced by the moisture content and the percentage and type of clay minerals in the soil. The three classes of expansive soil generally recognized are:

- Low - These soils range from sand to silt with varying amounts of clay minerals. The soils include sandy clay if the clay is kaolinitic and generally have a shrinkage index of less than 5. (Sand and gravel alluvial deposits and dredge tailings make up a fourth shrink-swell class which has no potential for volume change due to moisture change. This soil group is commonly placed in the low class.)

- Moderate - This class includes the silty clay to clay textured soils if the clay is kaolinitic and also includes heavy silt, light sandy clays, and silty clay with mixed clay minerals. The shrinkage index is generally between 5 and 7.

- High - This shrink-swell classification includes clay and clay with mixed montmorillonite. The shrinkage index of these soils is generally greater than 7.

b. Distribution

As Map III-3 shows, expansive soils exist over most of Butte County. Soils with no or low expansion potential are found generally along stream valleys and on steep mountain slopes. Soils of high expansion potential are found in the nearly level areas of the Sacramento Valley around the population centers of Chico, Oroville, Biggs, and Gridley.

6. Volcanics

Mount Lassen, considered to be one of the few active volcanoes in the continental United States, is located about 23 miles north of Butte County. The last series of volcanic eruptions at Mt. Lassen between 1914 and 1917 deposited volcanic ash over a fairly wide area surrounding the cone. Localized mudflows were also deposited in stream valleys around the volcanic cone. There is no record of any significant ash or mud deposit reaching Butte County within historic time.

While geologic hazards do exist in the Lassen Park area, the possibility of mudflows, flowing avalanches, or volcanic ash endangering the people of Butte County appears, from historical and geological data, very remote.

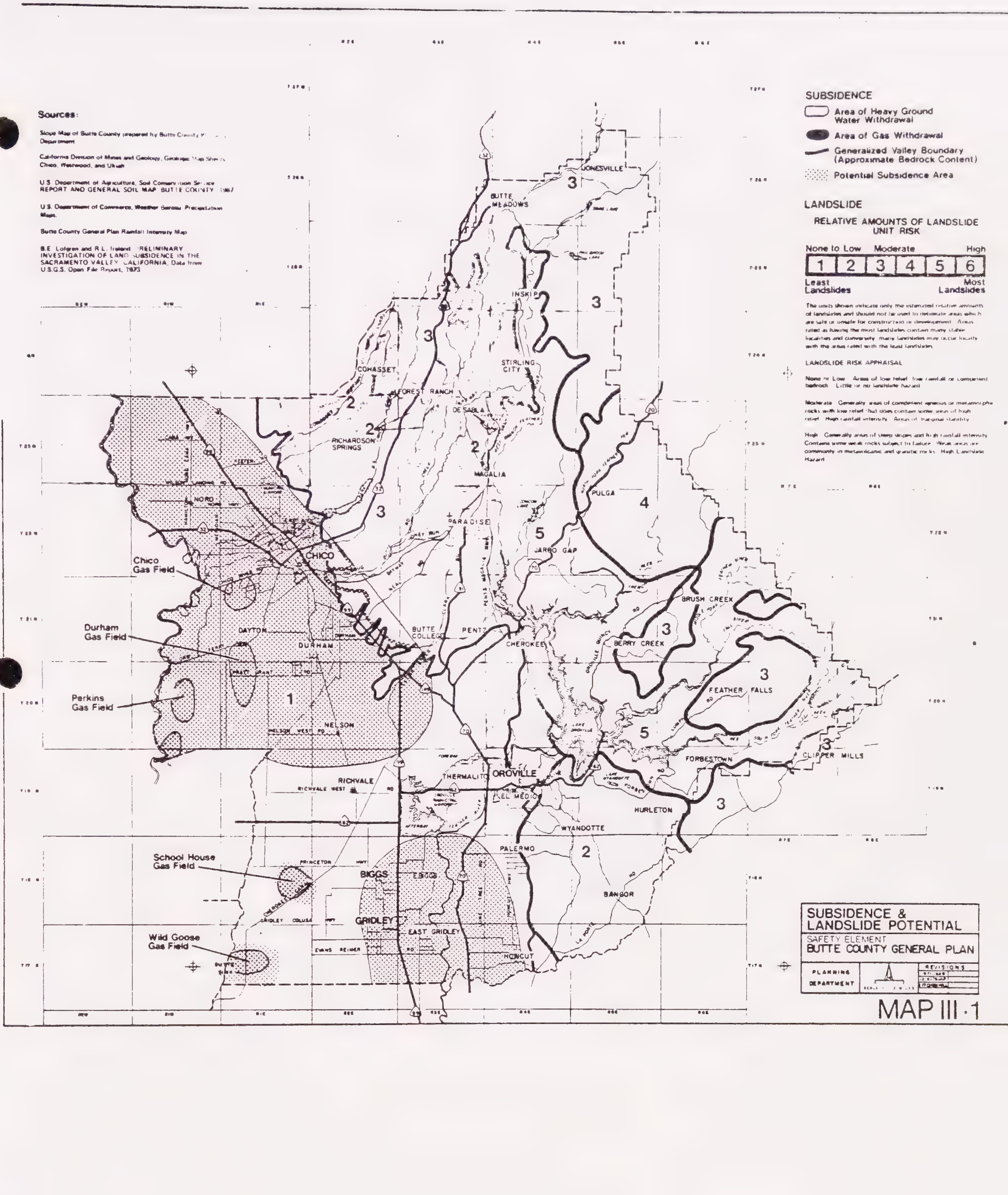
Lassen volcano is being studied and monitored by the U.S. Geological Survey for seismic and volcanic activity. According to Professor E. H. Williams of the University of California at Berkeley, the monitoring system can provide an early warning of a potential volcanic eruption.

7. Policies

Table 1 summarizes the Geologic Hazards findings discussed above, states the County's policy in response to the findings, and outlines implementation measures.

Table 1. GEOLOGIC HAZARD SUB-ELEMENT

FINDINGS	POLICY	IMPLEMENTATION
1. The identification of geologic hazards is in the public interest.	1. Inform the public of known geologic hazards.	1. Approve and publish the hazard maps in this plan element recognizing that this map is general and each site must be judged on its individual metit. Keep the information up-to-date.
2. Geologic hazards limit land development capabilities.	2. Consider geologic hazards in development of Land Use, Housing, Circulation, Conservation, and Open Space Elements.	2. Determine appropriate uses for high hazard areas. Establish limits on the density and type of development permitted in high hazard areas.
3. The risk of landslides is greatest in areas with slopes over 15%, weak rock, and high rainfall.	3. Consider landslide potential in review of private development and public facilities in areas rated 4 and 5 on Map III-1.	3. Require investigation of landslide potential for proposed development in areas with slopes over 15%, weak rock, and high rainfall. Present findings in environmental review and subdivision review.
4. The removal of surface material by rain and water varies by slope, soil, vegetation, precipitation and development. It is greatest in areas of granite rock.	4. Consider erosion potential in review of private development and public facilities in areas rated high and very high on Map III-2.	4. Where appropriate, require investigation of erosion potential for proposed development. Present findings in environmental review and subdivision review.
5. Ground surfaces can sink and cause significant damage in areas where there is extensive withdrawal of ground water, oil and gas.	5. Protect against subsidence from ground-water withdrawal and oil and gas withdrawal. Support the conservation of ground water from deep wells for use within the County.	5. Monitor sinking as necessary. Require investigation of subsidence potential in review of proposed withdrawals. Present findings in environmental review. Support canal projects to bring surface waters into Butte County whereever possible.
6. Many valley areas with clay soils have a high potential for structural damage from soil shrinking and swelling.	6. Protect development in valley areas with expansive soils.	6. Monitor shrinking and swelling as necessary. Require mitigation measures for large developments and major facilities when there is a potential for significant damage.
7. High water at peak periods causes significant erosion and other problems for valley farming areas.	7. Support development of erosion control projects.	7. Support protection of river banks with appropriate methods. Support dam projects in Northern California which are beneficial to erosion control.

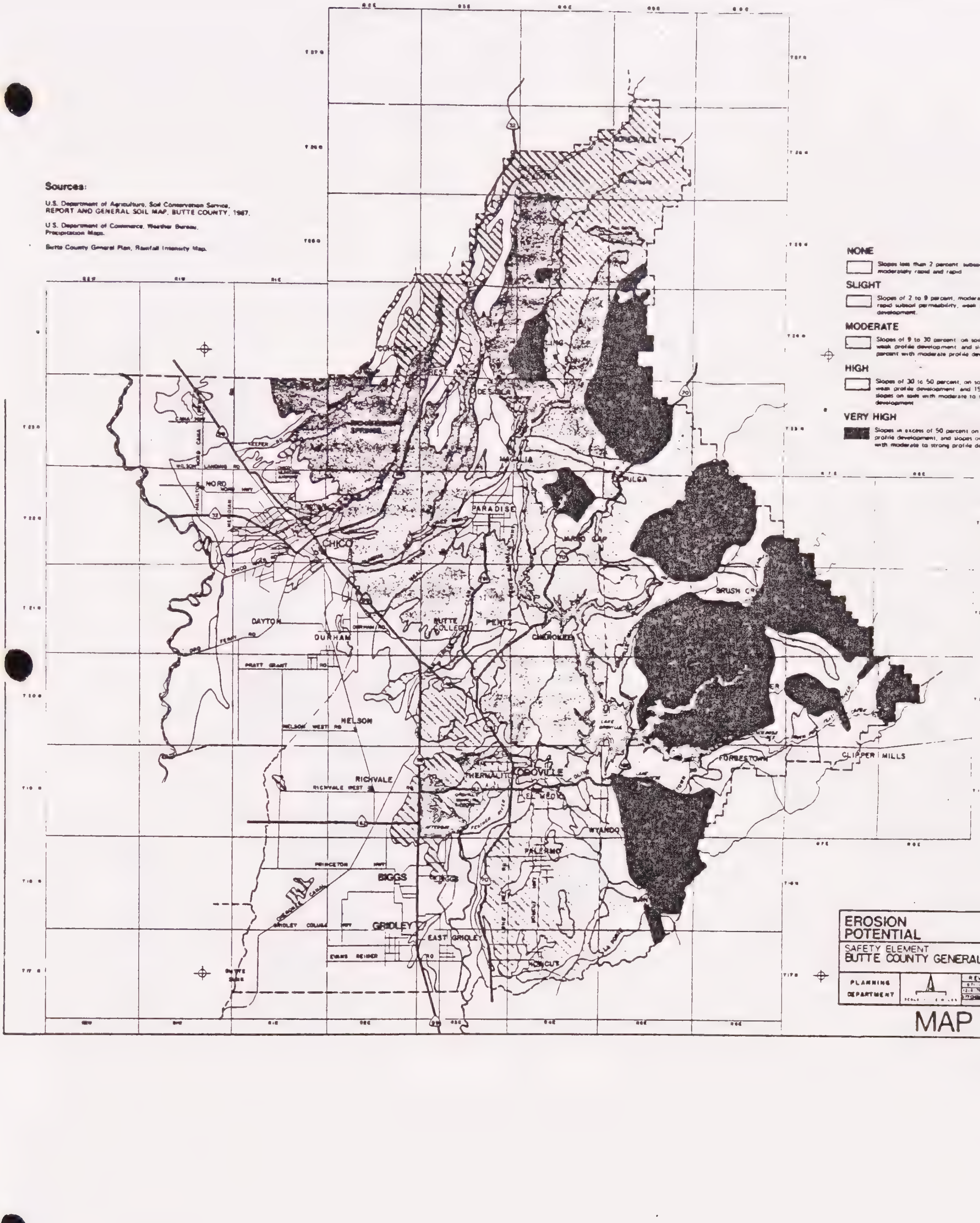

Sources:
Slope Map of Butte County prepared by Butte County Planning Department
California Division of Mines and Geology, Geologic Map Sheets Chico, Westwood, and Ukiah
U.S. Department of Agriculture, Soil Conservation Service REPORT AND GENERAL SOIL MAP BUTTE COUNTY 1967
U.S. Department of Commerce, Weather Bureau Precipitation Maps.
Butte County General Plan Rainfall Intensity Map
B.E. Lofgren and R.L. Ireland PRELIMINARY INVESTIGATION OF LAND SUBSIDENCE IN THE SACRAMENTO VALLEY CALIFORNIA, Data from U.S.G.S. Open File Report, 1973
SUBSIDENCE
Area of Heavy Ground Water Withdrawal
Area of Gas Withdrawal
Generalized Valley Boundary (Approximate Bedrock Content)
Potential Subsidence Area
LANDSLIDE
RELATIVE AMOUNTS OF LANDSLIDE UNIT RISK
None to Low
Moderate
High
1 2 3 4 5 6
Least Landslides
Most Landslides
The units shown indicate only the estimated relative amounts of landslides and should not be used to delineate areas which are safe or unsafe for construction or development. Areas rated as having the most landslides contain many stable localities and conversely, many landslides may occur locally with the areas rated with the least landslides.
LANDSLIDE RISK APPRAISAL
None or Low: Areas of low relief, low rainfall or competent bedrock. Little or no landslide hazard.
Moderate: Generally areas of competent igneous or metamorphic rocks with low relief that does contain some areas of high relief. High rainfall intensity. Areas of marginal stability.
High: Generally areas of steep slopes and high rainfall intensity. Contains some weak rocks subject to failure. Weak areas are commonly in metavolcanic and granitic rocks. High Landslide Hazard.
JONESVILLE
BUTTE MEADOWS
INSKIP
STIRLING CITY
COHASSET
FOREST RANCH
DE SABLA
RICHARDSON SPRINGS
MAGALIA
PULGA
PARADISE
JARBO GAP
NORD
CHICO
Chico Gas Field
Durham Gas Field
Perkins Gas Field
DAYTON
DURHAM
NELSON
BUTTE COLLEGE
PENTZ
CHEROKEE
BRUSH CREEK
BERRY CREEK
FEATHER FALLS
FORBESTOWN
CLIPPER MILLS
RICHVALE
THERMALITO
OROVILLE
EL MEDIO
HURLETON
WYANDOTTE
PALERMO
BANGOR
School House Gas Field
Wild Goose Gas Field
BIGGS
E. BIGGS
GRIDLEY
EAST GRIDLEY
HONCUT
SUBSIDENCE & LANDSLIDE POTENTIAL
SAFETY ELEMENT
BUTTE COUNTY GENERAL PLAN
PLANNING DEPARTMENT
REVISIONS
MAP III-1

Sources:

U.S. Department of Agriculture, Soil Conservation Service, REPORT AND GENERAL SOIL MAP, BUTTE COUNTY, 1967.

U.S. Department of Commerce, Weather Bureau, Precipitation Maps.

Butte County General Plan, Rainfall Intensity Map.



NONE

Slopes less than 2 percent, subsoil permeability moderately rapid and rapid

SLIGHT

Slopes of 2 to 9 percent, moderate to moderately rapid subsoil permeability, weak profile development.

MODERATE

Slopes of 9 to 30 percent on soils with no to weak profile development and slopes of 9 to 15 percent with moderate profile development

HIGH

Slopes of 30 to 50 percent, on soils with no to weak profile development and 15 to 30 percent slopes on soils with moderate to strong profile development

VERY HIGH

Slopes in excess of 50 percent on soils with no profile development, and slopes over 30 percent with moderate to strong profile development

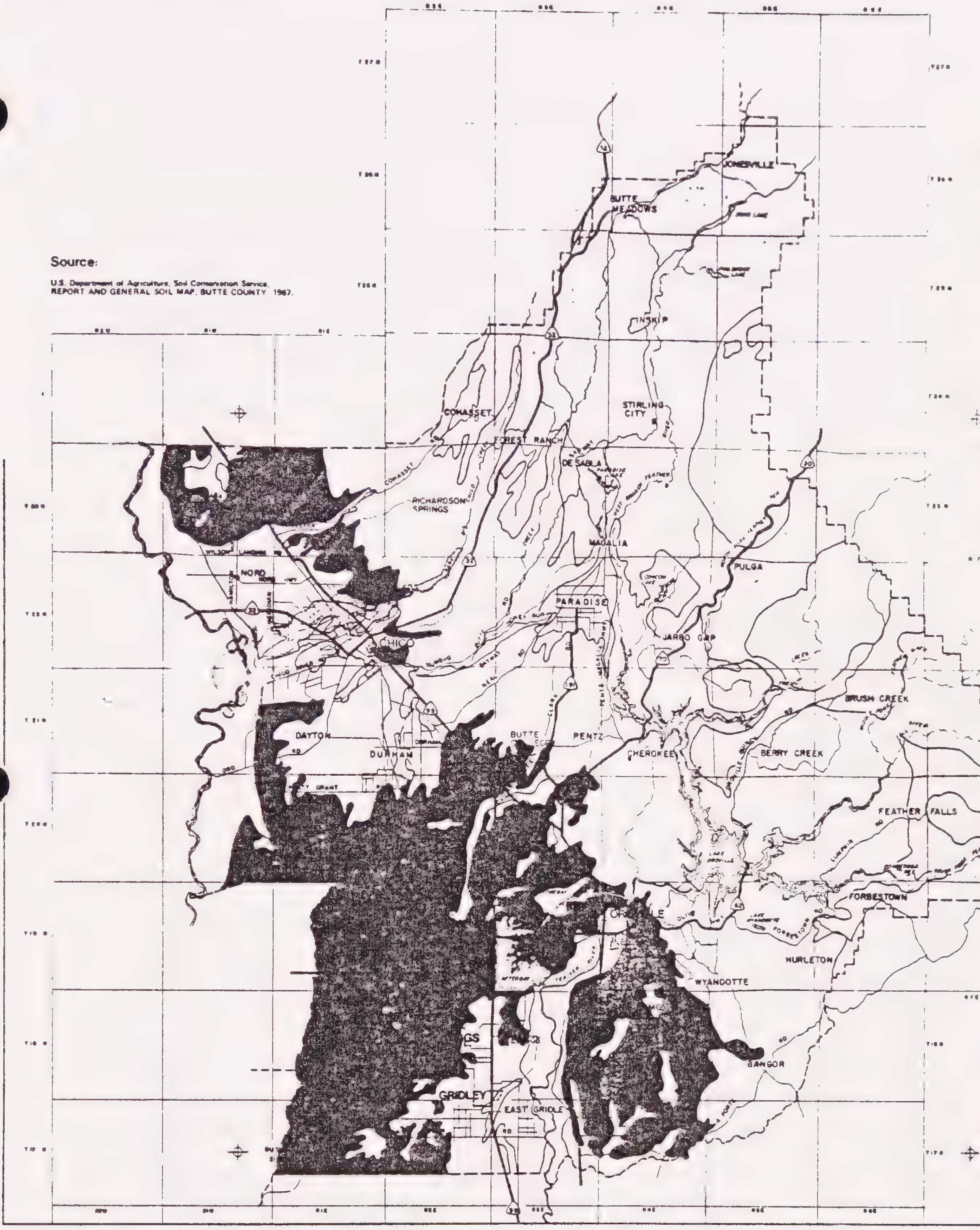
EROSION POTENTIAL

SAFETY ELEMENT
BUTTE COUNTY GENERAL PLAN

PLANNING DEPARTMENT

REVISIONS

MAP III-2



Source:

U.S. Department of Agriculture, Soil Conservation Service, REPORT AND GENERAL SOIL MAP, BUTTE COUNTY 1967.

LOW

Those soils range from sands to silt loams with any clay mineral and include sandy clay loams if the clay is kaolinitic. The Unified Soil Class can be ML, SM, CL, or SC and the shrinkage index is less than 5

MODERATE

This class includes the silty clay loam to clay textures if the clay is kaolinitic and heavy silt loams, light sandy clays and silty clay loams with mixed clay minerals. The Unified Soil Class is CH if the clay is kaolinitic or CL or ML if the clay minerals are mixed. The shrinkage index is between 5 and 7

HIGH

This class includes clay loams to clays with mixed or montmorillonitic clays. The Unified Soil Class is CH with mixed or montmorillonitic clays and the shrinkage index is greater than 7

Notes:

The expansiveness ratings are based upon the shrink swell potential of the soil

Shrink swell is that quality of the soil that determines its volume change with change in moisture content. Much damage to building foundations, roads, and other structures is caused by the shrinking and swelling of soils as a result of wetting and drying. The volume change is influenced by the amount of moisture and the kind and amount of clay in the soil. Three degrees of limitations are recognized. These are low, moderate and high

EXPANSIVE SOILS

SAFETY ELEMENT
BUTTE COUNTY GENERAL PLAN

PLANNING DEPARTMENT

REVISIONS

MAP III-3

C. FIRE HAZARDS

1. Objectives

The primary objective of the Fire Hazards sub-element is to prescribe policies to reduce loss of life, injuries, property damage, destruction of natural resources, and to deal effectively with the socio-economic disorder which could result from fires in the unincorporated areas of Butte County. Secondary objectives are to:

- Map and evaluate fire hazards
- Provide general criteria for the development of other General Plan elements
- Heighten public awareness of fire hazards

2. Hazards

The immediate impacts of a wildland fire include loss of valuable forests, wildlife, watersheds, and scenic resources along with the destruction of homes and other property. There may also be injury or loss of life. Secondary impacts include a reduction in the value of land and the further degradation of natural resources. Erosion, for example, results in siltation of lakes and rivers, increased flooding potential, poor water quality, and a reduction in desirable aquatic populations.

In recent years, fires have been more frequent in the valley than in the mountainous areas of the County. From 1971 through 1975, an average of 679 fires per year occurred in the valley compared to 306 in the foothills and mountains (see Appendix Table 1). Most of the valley fires have been grass fires near the more populated areas of Chico,

Durham, Richvale, Biggs, Gridley, and Oroville, and along the main roads connecting these communities.

Although there have been fewer fires in the foothill and mountain areas than in the valley, there has been a disproportionately higher number of fires per unit of population in the foothills and mountains. This condition is probably due to the more hazardous natural combination of dense vegetation, dry weather, and steep topography which encourages rapid fire spread. (The critical factor contributing to fire spread and intensity is the density and distribution of vegetative fuel, especially brush and forests.) The number of fire incidences in the foothill and mountain areas can be expected to increase along with an increase in recreational activities and residential uses.

Map III-4 shows the areas of varying fire hazard severity in the non-urban and unirrigated areas of the County. The fire hazard classes were identified according to the State Division of Forestry procedure described in the April 1973 report, <u>A Fire Hazard Severity Classification System for California's Wildlands</u>. The procedure allows delineation of areas of moderate, high, or extreme fire hazard based on natural factors in wildland areas (mostly those undeveloped areas in the foothills and mountains of eastern Butte County.) The Division of Forestry procedure is discussed in Appendix C.

A significant hazard to life and structures from wildland fire does not exist until a wildland area is developed and occupied. Not only does the introduction of human activity into wildlands increase fire occurrences, it also increases the demand for rapid response and control of those fires.

The rapid population growth of the State's urban areas, accompanied by an increase in affluence and leisure time, has resulted in a dramatic increase in the number of people

visiting and enjoying the recreation opportunities of Butte County. For much the same reason, the County's permanent population has also grown steadily. The problems of protecting life and property from fire hazards have increased significantly with the growing numbers of residents and visitors in the mountain and foothill areas. This trend has been somewhat accelerated by the development of Lake Oroville, which not only attracts large numbers of visitors to the area, but has also created intense pressures to develop nearby wildlands for year-round residential and commercial uses.

3. Fire Protection Services

Information on existing fire protection services, responsibilities, and adequacy of protection was derived from the Butte County Local Agency Formation Commission (LAFCO) report, Fire Protection in the Unincorporated Areas of Butte County, (July 1975), and from interviews with the staffs of local fire control agencies.

Fire protection for the unincorporated areas of Butte County is provided by several agencies. Two unincorporated areas, Paradise and El Medio, have formed fire protection districts. The foothill and mountain areas (State Zone) are protected primarily by the State Division of Forestry and the U.S. Forest Service. Fire protection for the unincorporated areas of the valley (Local Zone) is provided primarily by the Butte County Fire Department (BCFD). BCFD is also primarily responsible for suppressing non-forest fires (structures, vehicles, etc.) and for the protection of life in the State Zone.

BCFD is operated through a cooperative fire protection agreement between the County and the State Division of Forestry. The agreement places responsibility for the administration and operation of the Butte County Fire

Department with the Division of Forestry, while the County maintains policy and fiscal control. The State-County organization operates 23 fire stations, five lookouts, and 33 forest and structural fire trucks. The headquarters, maintenance shops, warehousing, and central fire dispatching facilities are in Oroville. The State also maintains an air tanker base at the Chico Airport and a Forestry Conservation Camp near Magalia. All fire agencies in the County are tied together by a well operated and sophisticated communication system.

The areas receiving fire protection from BCFD units, State units, and/or volunteer fire companies are shown in Figure 1. The valley area, which is protected by 11 fire stations (including cities) and eight volunteer fire companies, is divided into three protection units by the LAFCO report. The Local-State Zone boundary and the area served by the U.S. Forest Service are also shown in Figure 1.

The Butte County Department of Public Works reviews proposed developments for compliance with design standards and regulates street construction to provide for safe circulation. To provide for safe and quick access for fire service and for evacuation, the Public Works Department sets standards for maximum cul-de-sac length, maximum street grade, minimum road turning radii, and identification of roads and buildings. Even with these requirements, problems of road access, street naming, and house numbering have hampered responses to fire by control agencies.

Subdivisions, land divisions, and use permits are subject to review and approval by the County Fire Department for conformance to fire safety standards. New buildings must conform to the Uniform Building Code (UBC) requirements for fire protection systems and minimum fire resistance of materials. The County has not adopted the Uniform Fire

Code, a complementary code to the UBC. The Uniform Fire Code regulates the maintenance of property and certain dangerous and hazardous activities.

Fire protection service is adequate in the two special fire protection districts of Paradise and El Medio. The quality of service in the remaining unincorporated areas is described in the LAFCO report:

> "Quality of service is fair for areas within a 5 mile radius of the 11 fire stations, and where there is an adequate water supply and few exposure problems. For the most part this included area within the valley. Several key areas without adequate fire protection include the west side of Chico, Southgate Industrial Park, the community of Honcut, and scattered residences in the outlying areas. Structural fire protection for the mountainous communities is either marginal or non-existent. Areas receiving marginal protection include the Upper Ridge, Cohasset, Clipper Mills, Forest Ranch, and Stirling City. Areas with no strucutral fire protection include Bald Rock/Berry Creek, Feather Falls, Forbestown, Jarbo Gap/Concow/Yankee Hill, and Pentz/Cherokee/ Butte College."

Table 2 summarizes the adequacy of protection based on fire company equipment and manpower, response time, and water supply. Table 2 also includes the fire hazard classification for each area.

4. Policies

Table 3 summarizes the Fire Hazard findings discussed above, states the County's policy in response to the findings, and outlines implementation measures.

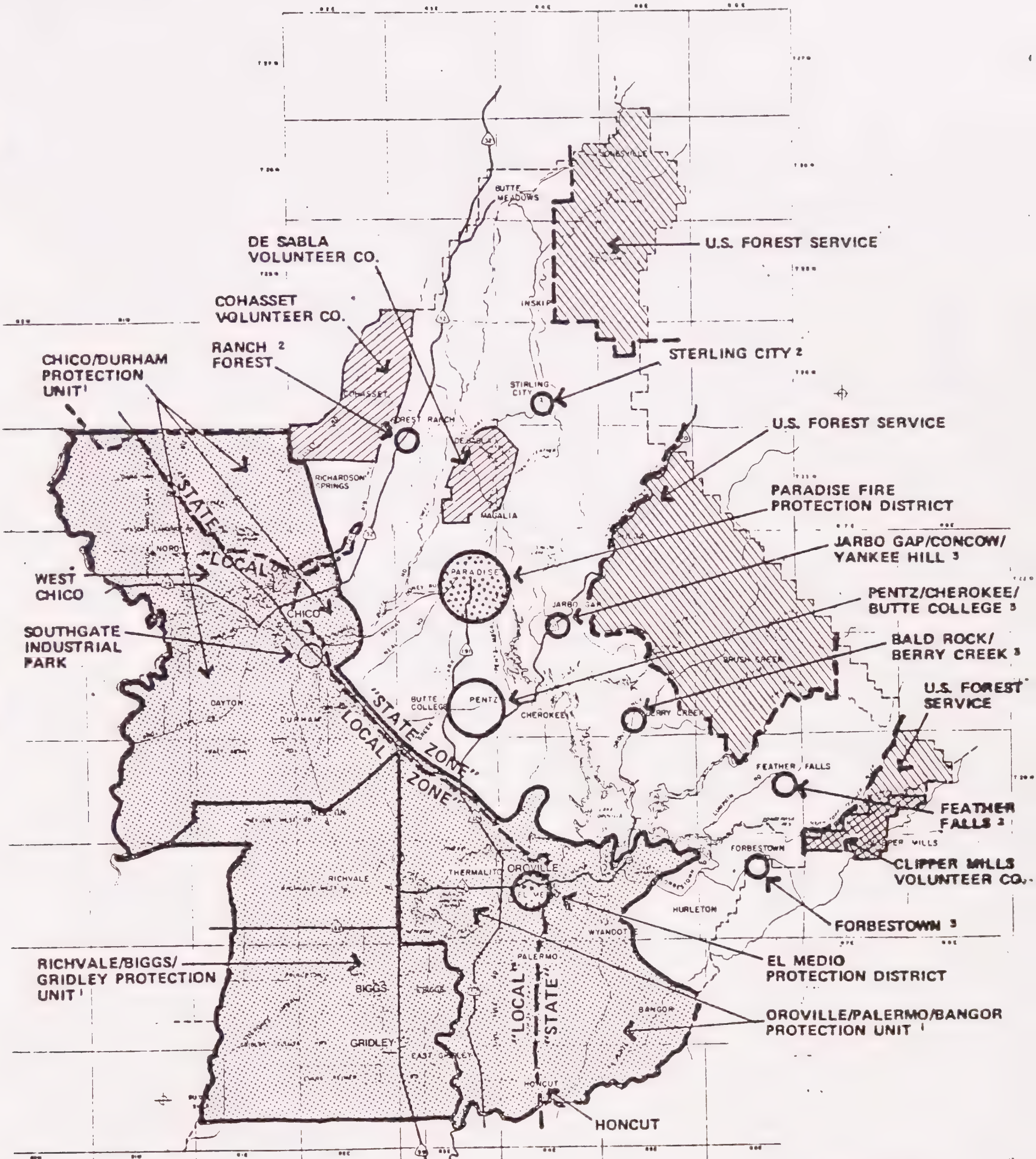


FIGURE 1

FIRE PROTECTION AREAS

SAFETY ELEMENT
BUTTE COUNTY GENERAL PLAN

PLANNING DEPARTMENT

SCALE: 1" = 8 MI.

REVISIONS

NOTES:
1. BUTTE COUNTY FIRE DEPARTMENT AND VOLUNTEER COMPANIES
2. VOLUNTEERS AND STATE DIVISION OF FORESTRY
3. STATE DIVISION OF FORESTRY

SOURCE: BUTTE COUNTY LOCAL AGENCY FORMATION COMMISSION. JULY 1975. FIRE PROTECTION IN THE UNINCORPORATED AREAS OF BUTTE COUNTY.

Table 2. ADEQUACY OF FIRE PROTECTION IN BUTTE COUNTY UNINCORPORATED AREAS

AREA[1]	PRIMARY SERVICE	RESPONSE TIME	WATER SUPPLY SYSTEMS	FIRE HAZARD SEVERITY[2]	ADEQUACY OF PROTECTION[3]
County Fire Dept. Areas					
1. Chico/Durham	4 BCFD stations + 2 Volunteer Co.	Majority of area within 10 minutes for first engine - adequate.	Chico area - good Durham - OK for simple fires. No others	Mostly low west of Hwy 99. Moderate to extreme east	N. Chico & Durham good. Remainder OK for simple fires only.
2. Richvale/ Biggs/Gridley	3 BCFD stations + 2 Volunteer Co.	Same as Above	Richvale - inadequate. No others. Extensive irrigation	Mostly low	Richvale - good near hydrants. Remainde OK for simple fires only.
3. Oroville/ Palermo/ Bangor	4 BCFD stations + 4 Volunteer Co.	Same as Above	Good systems in Oroville urban area. Several other small systems.	Mostly moderate with areas of high & extreme.	Adequate near hydra Other areas - OK for simple fires only.
Volunteer Fire Company Areas					
4. Cohasset	1 Volunteer Co.	Same as Above	None - 2 storage tanks.	High & extreme	Marginal
5. De Sabla	2 Volunteer Co.	Same as above	Paradise Pines - good. No others.	Mostly high	Marginal
6. Clipper Mills	1 Volunteer Co.	Varies - generally adequate	Merry Mtn. Village - good. No others.	Mostly high	Marginal beyond village area.
Independent Protection Districts					
7. Paradise	3 stations + Volunteers	All areas within 4-7 minutes for 3 engines - excellent.	Good	Varies	Very good
8. El Medio	1 station + Volunteers	All areas within 2-10 minutes for 3 engines - good.	Good	Low	Fair to good
Mountain Communities					
9. Forest Ranch	State + 1 Volunteer Co.	Varies	Several small systems.	High & extreme.	Marginal
10. Stirling City	State + 1 Volunteer Co.	Varies	System in town.	High & extreme	Marginal
11. Jarbo Gap/ Concow/ Yankee Hill	State only	None	None	High & extreme	None
12. Pentz/ Cherokee/ Butte College	State + Durham & Oroville Stations nearby	15-25 minutes from Durham & Oroville stations.	Butte College - good. No others.	Moderate to extreme.	Marginal
13. Bald Rock/ Berry Creek	State only	None	Lake Madrone - system in town. No others.	High & extreme.	None
14. Feather Falls	State + 1 Volunteer Co.	N.D.A.[4]	System in town.	High & extreme.	N.D.A.
15. Forbestown	State only	None	System in town.	High	None
Other Mountain Areas					
	State Div. of Forestry & U. S. Forest Service	Varies	Insignificant	High & extreme	None to marginal (Primarily Wildland Fire Control)

[1]See Figure III-1.

[2]Classification according to the State Division of Forestry report, A Fire Hazard Severity Classification System for California's Wildlands. April 1973. See Hazard Classes on Map III-4.

[3]Defined by LAFCO.

[4]No data available.

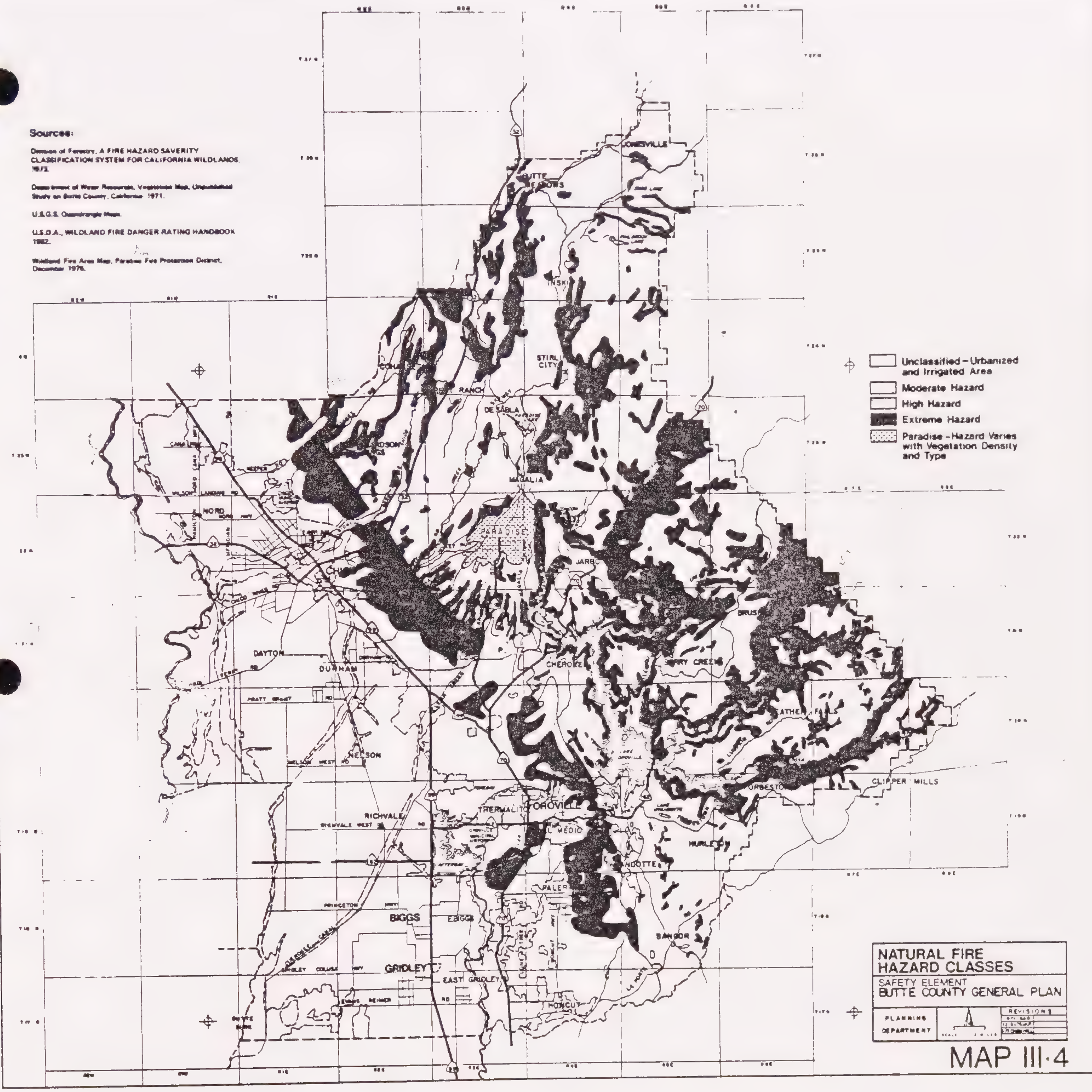
Source: Butte County Local Agency Formation Commission, Fire Protection in the Unincorporated Areas of Butte County. July 1975. Recommendations f new fire stations are from this report.

Table 3. FIRE HAZARD SUB-ELEMENT

FINDINGS	POLICY	IMPLEMENTATION
1. Most of the County has a natural fire hazard of at least moderate severity. Nearly all of the foothill and mountain areas have hazards of high or extreme severity.	1. Make protection from fire hazards a consideration in all planning, regulatory, and capital improvement programs, with special concern for areas of "high" and "extreme" fire hazard.	1. Consider fire hazards in all land use and zoning decisions, environmental review, subdivision review and the provision of public services.
2. The number of fire occurrences is increasing along with the increasing numbers of visitors and residents in the County.	2. Encourage adequate fire protection services in all areas of population growth and high recreation use.	2. Identify present and future limits of adequate fire protection services. Guide development to those areas through zoning, and development review processes.
3. Vegetation is the critical factor in fire spread.	3. Use fuelbreaks along the edge of developing areas in "high" and "extreme" fire hazard areas.	3. Require fuelbreaks where feasible within "high" and "extreme" fire hazard areas. Enforce regulations on vegetation clearance around structures.
4. Fire protection facilities are marginal in some areas of the County.	4. Attempt to upgrade fire service where economically feasible.	4. Promote formation of voluntary fire companies in remote areas. Construct additional facilities and services as desired by area residents and as economically feasible.
5. Development in reservoir watersheds can affect community water supplies.	5. Carefully evaluate the effect of development on water supplies.	5. Prepare land use plans for critical watershed areas. Consider possible damages to watershed in environmental review.
6. Fire control and suppression is often restricted by inadequate water supplies.	6. Determine the level of water supplies necessary for new development for fire protection purposes.	6. Develop fire protection standards for individual and community water systems serving new development.

Table 3. FIRE HAZARD SUB-ELEMENT (continued)

FINDINGS	POLICY	IMPLEMENTATION
7. Access to fires by emergency equipment is often limited by inadequate water supplies.	7. Ensure that road access for new development is adequate for fire protection purposes.	7. Develop standards for widths, grades, and curves of new roads to permit passage and maneuvering of emergency vehicles. Require multiple access where feasible.
8. Fire report and response times are often delayed by inconsistencies and deficiencies in street naming and house numbering.	8. Require or promote the easy identification of streets and developed properties.	8. Develop and implement a consistent street naming and house numbering system for the entire County. Require all names and numbers to be clearly visible.
9. Some human activities and land uses have a high potential for causing fires.	9. Regulate as necessary those activities and uses with a high fire potential except uses regulated by the Forest Practices Act.	9. Hold hearings to adopt the Uniform Fire Code or modifications thereof.
10. In higher than average fire hazard areas, certain types of building materials are less flamable.	10. Regulate use of certain building materials in areas of higher than average fire hazard.	10. Adopt building code regulations for roofing and siding materials in fire hazard areas.
11. Many residential areas of high and extreme fire risk have swimming pools.	11. Require water connection to pool for fire purposes.	11. Adopt building code requirements for such connections.



Sources:

Division of Forestry, A FIRE HAZARD SAVERITY CLASSIFICATION SYSTEM FOR CALIFORNIA WILDLANDS, 1973.

Department of Water Resources, Vegetation Map, Unpublished Study on Butte County, California 1971.

U.S.G.S. Quadrangle Maps.

U.S.D.A., WILDLAND FIRE DANGER RATING HANDBOOK 1962.

Wildland Fire Area Map, Paradise Fire Protection District, December 1976.

NATURAL FIRE HAZARD CLASSES

SAFETY ELEMENT
BUTTE COUNTY GENERAL PLAN

PLANNING DEPARTMENT

REVISIONS

MAP III-4

SAFETY-SUPPORT DATA

CONTENTS

TABLE

FIGURE

DEFINITIONS

ALLUVIAL - Pertaining to or composed of alluvium, or deposited by a stream or running water. (AGI, 1972).

ALLUVIUM - A general term for clay, silt, sand, gravel or similar unconsolidated detrital material deposited during comparatively recent geologic time by a stream or other body of running water as a sorted or semisorted sediment in the bed of the stream or on its flood plain or delta, or as a cone or fan at the base of a mountain slope. (AGI, 1972).

BLOCK SLIDE - A translational landslide in which the slide mass remains essentially intact, moving outward and downward as a unit, most often along a pre-existing plane of weakness such as bedding, foliation, joints, faults, etc. (AGI, 1972).

COHESION - Shear strength in a sediment not related to inter-particle friction. (AGI 1972).

CONSOLIDATED MATERIAL - Soil or rocks that have become firm as a result of compaction.

DEBRIS SLIDE - The rapid downward movement of predominantly unconsolidated and incoherent earth and debris in which the mass does not show backward rotation but slides or rolls forward, forming an irregular hummocky deposit which may resemble morainal topography. (Sharpe, C.F.S., *Landslides and Related Phenomena*, p. 74, 1938).

DIFFERENTIAL SETTLEMENT - Nonuniform settlement; the uneven lowering of different parts of an engineering structure, often resulting in damage to the structure (AGI, 1972).

LIQUEFACTION - Change of water saturated cohesionless soil to liquid, usually from intense ground shaking; soil loses all strength.

METAVOLCANICS - Partly metamorphosed volvanic rocks. (Stokes and Varnes, p. 91, 1955).

ROCKFALL - The relatively free falling of a newly detached segment of bedrock of any size from a cliff, steep slope, cave, or arch. (Sharpe, C.F.S., *Landslides and Related Phenomena*, p. 78, 1938).

UNCONSOLIDATED MATERIAL - A sediment that is loosely arranged or unstratified or whose particles are not cemented together, occurring either at the surface or at depth (AGI, 1972).

WATER TABLE - The surface between the zone of saturation and the zone of aeration; that surface of a body unconfined ground water at which the pressure is equal to that of the atmosphere (AGI, 1972).

DEBRIS SLIDE

Debris slides or slumps are incoherent or broken masses of rock and other debris that move downslope by sliding on a surface that underlies the deposit. This type of failure is sometimes termed "arcuate" and is most common in massive, weak, saturated material which includes thick sections of clay soil and poorly compacted artificial fills. The movement of the landslide is partly rotational with the failure zone typically described as an arc.

BLOCK GLIDE

A block glide is a landslide which has failed along an unsupported or weak plane. The plane of weakness is usually a bedding plane, joint plane, fault plane, erosional plane, or formation contact. Block glides typically occur in highly metamorphosed igneous and sedimentary rocks which have undergone intensive deformation and contain well-defined joint surfaces or shear zones. Block glides also include layered rock of sedimentary or igneous origin which has been dissected by stream erosion with resulting deep canyons.

MUDFLOWS OR EARTHFLOWS

Mudflows or earthflows consist of saturated soil mass and/or weathered rock moving on an underlying surface of more competent soil or bedrock. This type of flow generally involves rapid downslope movement of saturated weak materials on competent bedrock. They typically originate on moderately steep hillsides where the surface soils are well developed and overlie poorly drained rock or soil. Mudflows are common in areas of intense rainfall, steep slopes, and little vegetation or where the vegetation has been removed by man or fire. Because mudflows move for long distances, they can result in considerable damage to developments along streams and canyons.

ROCKFALLS

Rockfalls involve the free fall of weathered rock down a steep slope. They sometimes form as avalanches of loose rock on very steep slopes with little or no vegetation. Rockfalls are most common on slopes with gradients greater than 50 percent and where natural weathering has produced fractured rock with little soil cover.

Table 1. BUTTE COUNTY REPORTED FIRE INCIDENCES[1]

LOCAL ZONE (1971-1975)

	Vegetation	Structural	Vehicular	Improvement	Refuse	Total
1971	343	155	73	30	49	650
1972	358	138	94	38	45	673
1973	429	153	96	60	45	783
1974	387	124	83	26	36	656
1975	334	129	83	45	41	632
TOTALS	1,851	699	429	199	216	3,394
AVERAGES	370	140	86	40	43	679

STATE ZONE (1971-1975)

	Lightning	Campfire	Smoking	Debris	Arson	Equip. Use	Railroad	Play W/Fire	Elect. Power	Misc.	Undet.	Total
1971	5	7	46	27	62	35	21	33	8	30	30	304
1972	8	7	20	23	36	19	5	26	7	22	33	206
1973	12	6	29	21	57	27	3	38	15	36	60	304
1974	8	6	31	31	94	29	13	27	6	51	53	349
1975	8	8	31	40	64	33	23	35	8	65	52	367
TOTALS	41	34	157	142	313	143	65	159	44	204	228	1,530
AVERAGES	8	7	31	28	63	29	13	32	9	41	46	306
TOTAL FIRES IN LOCAL AND STATE ZONES, 1971-1975												4,924
ANNUAL AVERAGE IN LOCAL AND STATE ZONES												985

PARADISE FIRE PROTECTION DISTRICT (1972-1975)

	Vegetation	Structural	Vehicular	Total
1972	56	35	35	126
1973	53	51	37	141
1974	73	52	32	157
1975	54	41	38	133
TOTALS	236	179	142	557
AVERAGES	59	45	36	139

[1] Does not include U.S. Forest Service lands, incorporated areas, and the unincorporated area of El Medio.

FIRE HAZARD SEVERITY CLASSIFICATION PROCEDURES

Fire hazard classes were identified by combining maps of the critical fuel, weather, and slope factors and using the Severity Scale shown below. Fuel classes were identified using a Department of Water Resources vegetation map from an unpublished 1971 study on Butte County's economic resources and a 1976 field survey of the Paradise area. Critical Fire Weather Frequency classifications were determined from the Division of Forestry report. Slopes were plotted from U.S. Geological Survey quadrangle maps. These maps are on file at the Butte County Planning Department.

According to the Division of Forestry report, vegetation, weather, and ground slope are the most significant factors which determine the intensity of a fire and the severity of the hazard. The type of vegetation, its density, and its condition (moisture content, size, etc.) largely determine fire intensity and rate of spread. Conditions contributing to a high intensity fire include a high fuel density, low moisture content, and a high proportion of large-sized wood. Critical weather factors include wind, temperature, relative humidity, and precipitation. Wind has the greatest effect on the rate of fire spread. Generally fires burn more rapidly upslope than downslope, and the rate of spread increases with an increase in slope. Steep slopes also restrict accessibility, increase travel time to fires, and limit the type of equipment that can be used to control the fire.

Figure J. FIRE HAZARD SEVERITY SCALE*

	CRITICAL FIRE WEATHER FREQUENCY								
	I (1)			II (2)			III (8)		
	% SLOPE			% SLOPE			% SLOPE		
FUEL LOADING	0-40 (1)	41-60 (1.6)	61+ (2.0)	0-40 (1)	41-60 (1.6)	61+ (2.0)	0-40 (1)	41-60 (1.6)	61+ (2.0)
Light (Grass) (1)	1	1.6	2	2	3.2	4	8	12.3	16
Medium (Scrub) (8)	8	12.8	16	16	25.6	32	64	102.4	128
Heavy (Woods-Brushwood) (16)	16	25.6	32	32	51.2	64	124	204.8	256

MODERATE HAZARD   HIGH HAZARD   EXTREME HAZARD

*Severity Factor Values Are Shown In Parentheses

The Division of Forestry procedure shown in Figure C-1 above divides fuel (vegetation), weather, and slope into three classes. Each class is assigned a severity factor. Multiplying the severity factors in matrix form results in a range of values from 1 (light grass, mildest weather, 0-40 percent slope) to 256 (heavy woods, most severe weather, over 60 percent slope). These values are divided into three fire hazard classes - moderate, high, and extreme. As stated in the Division of Forestry report, "The resulting class designation is logical in relation to expected fire behavior and potential fire damages. Three classes were also a practical number from the standpoint of specifying different conditions under which land use and development should take place in the wildlands."

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REFERENCES

GEOLOGIC HAZARDS

AGI, 1972. *Glossary of Geology*, American Geological Institute, Washington, D. C.

Alfors, J. T., John L. Butnett, and Thomas E. Gay, Jr., 1973. *Urban Geology*, California Division of Mines and Geology Bulletin 198.

Bailey, E. H., 1966. *Geology of Northern California*, California Division of Mines and Geology Bulletin 190.

_____, 1972. *Seismic Safety Information Key: 72-1, 72-2, 72-3, 72-4, 72-5, 72-6, 72-7, 72-8*, California Division of Mines and Geology.

Borcherdt, R. D., 1975. *Studies for Seismic Zonation of San Francisco Bay Region*, U. S. Geological Survey Professional Paper 941-A.

Bowen, Oliver E., Jr., 1962. *Geologic Guide to the Gas and Oil Fields of Northern California*, California Division of Mines and Geology Bulletin 181.

Compton, Robert R., 1955. Trondhjemite Batholith Near Bidwell Bar, California, *Bulletin of the Geological Society of America*, Volume 66, pp. 9-44.

Jenkins, O. P., 1960. *Geologic Map of California Ukiah Sheet*, California Division of Mines and Geology.

_____, 1960. *Geologic Map of California Westwood Sheet*, California Division of Mines and Geology.

_____, 1962. *Geologic Map of California Chico Sheet*, California Division of Mines and Geology.

Jennings, Charles, 1975. *Fault Map of California*, California Division of Mines and Geology.

Linsley, Ray K., 1956. *The Relation Between Rainfall Intensity and Topography in Northern California*, Department of Civil Engineering, Stanford University.

Lofgren, B.E., and R. L. Ireland, 1973. *Preliminary Investigation of Land Subsidence in the Sacramento Valley, California*, U. S. Geological Survey Open-File Report, Sacramento, California.

Olmsted, F. H., and G. H. Davis, 1961. *Geologic Features and Ground-Water Storage Capacity of the Sacramento Valley California*, U. S. Geological Survey Water Supply Paper 1497.

Sherburne, R. W., and C. J. Hauge, 1975. *Oroville, California, Earthquake, 1 August 1975*, California Division of Mines and Geology Special Report 124.

FIRE HAZARDS

Butte County Local Agency Formation Commission, July 1975. *Fire Protection in the Unincorporated Areas of Butte County.*

Butte County Planning Department, 1976. Office copies of USGS quadrangle maps with plotted slope zones (30-40%, 40-60%, 61+%).

California Department of Conservation, Division of Forestry, June 1972. *Recommendations to Solve California's Wildland Fire Problem.*

California Department of Conservation, Division of Forestry, April 1973. *A Fire Hazard Severity Classification System for California's Wildlands.*

California Department of Conservation, Division of Forestry, April 1973. *An Evaluation of Efforts to Provide Fire Safety to Development and Occupancy Within the Wildlands of California.*

California Department of Water Resources, 1971. Vegetation map from an unpublished study on Butte County's economic resources.

Clarence, C. R. and L. R. Chatten, 1966 Ed. *Principles of Forest Fire Management.*

County Supervisors Association of California, March 1965. *Fire Safety Guides for California Watersheds.*

Folkman, William S., 1967. *Evaluation of Fire Hazard Inspection Procedures in Butte County, California*, Pacific Southwest Forest and Range Experiment Station, U. S. Forest Service Research Note PSW-145.

Folkman, William S., 1973. *Fire Prevention in Butte County, California...Evaluation of an Experimental Program*, Pacific Southwest Forest and Range Experiment Station, USDA Forest Service Research Paper PSW-98/1973.

USDA, Forest Service, 1974. *Can Southern California Wildland Conflagrations Be Stopped?*, General Technical Report PSW-7/1974.

USDA, Pacific Southwest Forest and Range Experiment Station, 1962. *Wildland Fire Danger Rating Handbook*, fire danger rating area maps.

USDA, Pacific Southwest Forest and Range Experiment Station, 1965. *Residents of Butte County, California: Their Knowledge and Attitudes Regarding Forest Fire Prevention*, Research Paper PSW-25.